THE PERCEPTUAL PROMINENCE OF PITCH ACCENT TYPES IN GERMAN

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ABSTRACT

The paper reports on a web-based perception experiment investigating the perceptual prominence of seven attested nuclear pitch accent types plus deaccentuation in German. Unlike previous studies which link prominence judgments of accents to aspects of intonational meaning, the present study *directly* asks for the perceived degree of prosodic prominence.

Results reveal gradual differences between accent types, which can be defined along three tonal dimensions which have an impact on prominence perception: the direction of pitch movement (rises being more prominent than falls), the degree of pitch excursion (steeper excursion adding to the degree of prominence) and the height of the starred tone (high accents being more prominent than downstepped and low accents).

Keywords: Prominence, pitch accent type, German, perception, intonation.

1. INTRODUCTION

Only few studies have directly investigated the perceptual prominence of different types of pitch accent. If accent *types* are addressed at all – since the analysis of accents is often reduced to a two-way distinction between accented and unaccented items – their prominence is generally addressed as a side effect of its relation to specific aspects of (linguistic or paralinguistic) meaning. That is, the primary research question is often concerned with the contextual interpretation or appropriateness of an element's prosody but not (or only indirectly) with the element's perceived prominence, defined here as the psychoacoustic impression of 'standing out' in relation to neighbouring elements.

Accent types are defined by differences in the form of a tonal movement in the vicinity of a (postlexically) stressed syllable. This implies the basic direction of a movement (rise vs. fall), the scaling and height of pitch (vertical axis) and the alignment or synchronisation of a pitch peak or valley with a stressed syllable (horizontal axis). In fact, the relation of tonal cues to perceived prominence is complex (see [28]). This is why previous studies only investigated selected tonal cues to prominence by concentrating on single accent types. Additionally, the position of a pitch accent in a phrase (prenuclear vs. nuclear, see [2]) and non-tonal cues, such as duration and intensity, play an important role in prominence perception (see e.g. [8], [19]).

Studies on the relative prominence of rising-falling nuclear peak accents in West Germanic languages by Rietveld & Gussenhoven [24],[11] on Dutch and Ladd & Morton [16] on (Scottish and British) English have shown that higher pitch peaks are generally perceived as more prominent (in identical contexts). More accurately, perceived prominence does not seem to be a correlate of absolute pitch *height* but of relative pitch *excursion* (the larger the more prominent, cf. also [30]). Furthermore, a later peak may create the same prominence-lending effect as a higher peak, thus serving as a perceptual substitute [10]. In fact, it has been shown that the overall shape of an accent or contour, in particular the excursion and slope of a rise or fall and its alignment with an accented syllable, has an important impact on the syllable's perceived prominence (see [15], [18] for German, [13] for English).

The rare studies on the contribution of different accent-lending pitch movements on prominence perception reveal conflicting evidence, even in typologically closely related languages: Hermes & Rump [12] reported in a study on Dutch that nuclear falls (i.e. medial peak accents) were judged as more prominent than rises, excursion sizes being equal. In contrast, Baumann [4] found in a study on German that rising nuclear accents were more often judged as prominent by naive annotators than high (here: medial peak accents) and falling accents (here: early peak accents).

As mentioned above, many studies on accent types rather deal with their appropriateness in various contexts, indicating different types of intonational meaning, especially information structure. Thus, the judgment of prominence is at best indirect. In their seminal study on American English, Pierrehumbert & Hirschberg [22] broadly assign high accents to new, downstepped accents to accessible and low accents to given discourse referents. The most obvious conclusion would be: the higher the pitch on an accented syllable (i.e. on the starred element in autosegmental-metrical terms), the more prominent

it is – assuming that prominence is interpreted either as newness or focus (reflecting the Effort Code [10]). This is in line with another important study on American English by Ayers [2], who tested the correlation between 'informational prominence' and nuclear accent types (high, downstepped, rising) by measuring reaction times. High/'neutral' and rising/ 'contrastive' accents were responded to more quickly than downstepped/'expected' accents, which was interpreted as indicating a higher degree of perceptual prominence of non-downstepped accents.

For German, Kohler [14] investigated the question of peak alignment differences in single-accent sentences and the influence of these differences on the sentences' linguistic and paralinguistic meanings. He found that the change from an early to a medial peak accent (or: from a falling to a high accent) caused a perceptual change from given/accessible to new information, i.e. a linguistically relevant change, while the change from a medial to a late peak adds greater involvement or surprise, basically a paralinguistic value. Röhr & Baumann [26] and Baumann & Riester [6] developed a more fine-grained relation between degrees of givenness or information status categories and accent type in German. In general, they detected a stepwise decrease in the degree of perceived givenness from deaccentuation (and prenuclear accents) through low and early peak nuclear accents to high and rising nuclear accents.

Other accent type studies did not investigate the information status of referring expressions but different types of focus. Peters [21], e.g., found in Hamburg German production data that narrow focus is marked by late peaks in contrast to broad focus expressions, whose accent peaks are earlier. This result is in line with a recent production and perception study on Standard German suggesting that the most important factor in marking contrastive versus broad focus is the question of whether the *onglide* to the accented syllable is rising (contrastive) or falling (broad) (see [25]). Again, rises are indirectly related to a higher degree of prominence than falls.

The present study investigates – for the first time – the degree of prosodic prominence of accent types in German *directly*, using the current inventory of the autosegmental-metrical GToBI model [9]. Based on some of the earlier studies reported above, we hypothesize a stepwise difference of accent types in perceived prominence as a function of three dimensions, ranked according to their assumed importance (">" means "more prominent than") (see Table 1):

1. Direction of pitch movement on the accented syllable (reflecting different types of peak alignment): late peaks /rises > medial peaks /rises > early peaks /falls (cf. [14], [4], [25])
2. Pitch excursion: steep > shallow (cf. [16], [24])
3. Pitch height of the starred tone: H* (high) > !H* (downstepped) > L* (low) (cf. [22])

Table 1: Hypothesis of the study: GToBI accent types (plus deaccentuation 'Ø'), ordered according to their perceptual prominence (increasing from bottom to top), based on their characteristics with regard to three tonal dimensions.

Accent type	Pitch movement	Pitch excursion	Height of starred tone
L+H*	rise	steep	H
L*+H	rise	steep	L
H*	rise	shallow	H
!H*	rise	shallow	!H
H+!H*	fall	(relatively) steep	!H
H+L*	fall	steep	L
L*	fall	shallow	L
Ø	n/a	n/a	n/a

2. METHOD

2.1. Test material

Different accent types were tested on the proper names *Lana*, *Lona* and *Lina* within the following target sentence:

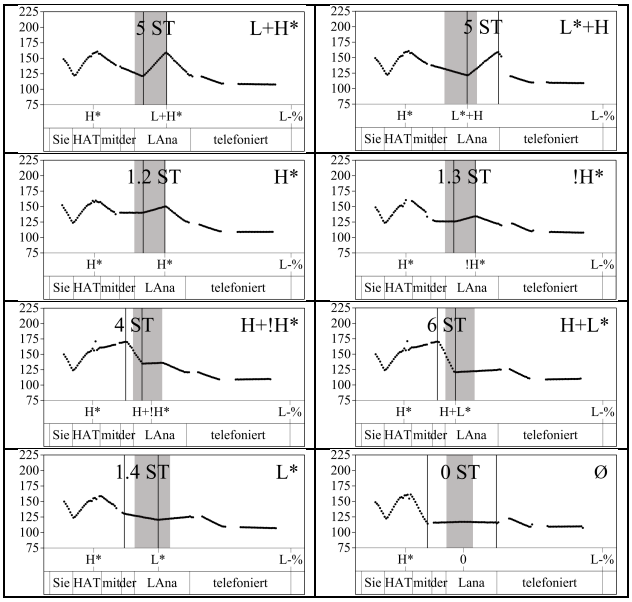
(1) Sie hat mit der Lana/Lona/Lina telefoniert.
lit. *she has with the Lana/Lona/Lina phoned*
'She was on the phone with Lana/Lona/Lina.'

The accent types examined are based on natural speech from a female (age 30) and a male (age 25) model speaker of Standard German. They both grew up slightly north and south of the Benrath isogloss, respectively, and have advanced expertise in intonation analysis. They produced each target sentence with eight different intonation contours: All target sentences displayed a rising accent on the auxiliary verb *hat* and a sentence-final low boundary tone. The target words/proper names were realized with seven nuclear pitch accent types, categorized according to GToBI (see [9]) listed in Table 1. In addition, we tested target sentences with a nuclear accent on the auxiliary and no accent (Ø) on the target word.

In order to keep the (prosodic) variability of the test sentences to a minimum, we chose one carrier sentence for both speakers – *Sie hat mit _ telefoniert* – and inserted the different target words plus definite article from the recorded target sentences (after normalization in amplitude). We adjusted these test sentences as to pitch scaling and alignment (with equivalent semitone values for both speakers; see Figure 1), and to syllable duration (see Table 2) in order to create constant accent types for each speaker. The intensity value for all target words was

kept at 82 dB. For pitch and duration manipulations we used *Praat* [7] and for intensity *Audacity* [1].

Figure 1: Examples of eight manipulated F0 contours (male speaker) on the test sentence *Sie hat mit der Lana telefoniert* ('She was on the phone with Lana') with relevant F0 movements in semitones (ST) and the accented/stressed syllable of the target word shaded (*Lana*).



We adjusted the syllable duration of the target words in relation to their intrinsic vowel durations (cf. [27]): the more open the vowel (i < o < a) the longer the syllable (difference of 20 ms each). Moreover, the duration of a syllable differs as a function of the type of accent it carries (cf. [26], [4]): L* accents have been found to cooccur with longer durations than other accent types, while deaccentuation takes shorter syllable durations. These insights were taken into account when setting up the stimuli (see Table 2). In sum, we tested 48 stimuli (8 intonation patterns * 2 voices * 3 target words).

Table 2: Syllable duration (ms) of target words.

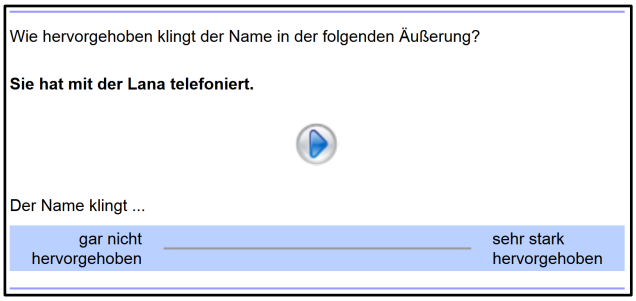
Syllables of target words	Accentuation on proper name		
	Ø	L*	H+L*, H+!H*, !H*, H*, L*+H, L+H*
der	110		
La-	180	220	205
Lo-	160	200	185
Li-	140	180	165
-na	150		

2.2. Procedure

We conducted the perception experiment by means of a web-based questionnaire implemented with the software 'SoSci Survey' [17].

The subjects' task was to evaluate how highlighted/prominent the proper name sounds in each test sentence. They were told to give their judgments by placing a roll bar on a continuous horizontal line (visual analogue scale) with the left pole labelled 'not at all highlighted' and the right pole labelled 'strongly highlighted' (see Figure 2). The responses were encoded as interval data ranging from 1 (left pole) to 100 (right pole). Accordingly, higher ratings reflected a higher degree of perceptual prominence.

Figure 2: Example of the experimental setup in the web-based perception experiment.



After a short practice section, the evaluation was carried out for each test sentence (48 stimuli) separately and in randomised order. The test sentence was presented orthographically and acoustically. Subjects were able to control when and how often to play a stimulus.

2.3. Subjects and analysis

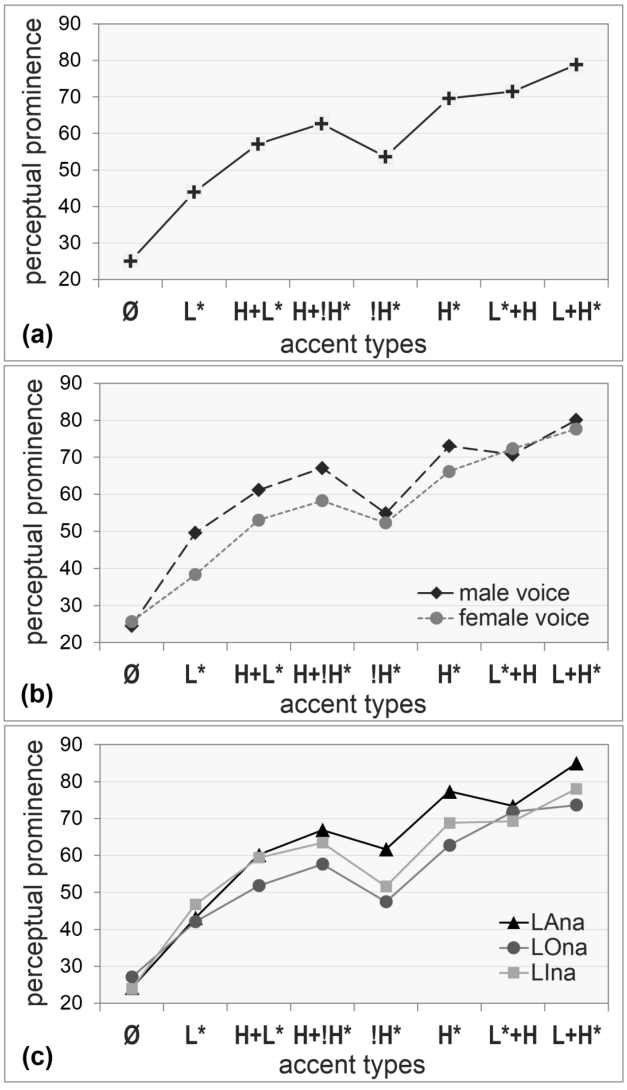
Sixty-eight native German speakers (78% female) aged between 18 and 30 years (mean = 21.6, SD = 2.6) took part in the experiment. They grew up in nine different German Federal States (57% in North Rhine-Westphalia) and did not report any hearing impairment. The subjects were second semester bachelor students at the linguistics department of the University of Cologne with basic knowledge in speech analysis.

We performed a linear mixed effects analysis of the relationship between perceptual prominence (dependent measure) and accent types by using R [23] and *lme4* [3]. We included subjects as random intercepts. Accent type, voice (male, female), and target word (*Lana*, *Lona*, *Lina*) were included as fixed effects, as well as the interactions between accent type and voice and between accent type and target word. We report p-values based on likelihood ratio tests. Visual inspection of residuals did not reveal any obvious deviations from homoscedasticity or normality.

3. RESULTS AND DISCUSSION

The likelihood ratio test revealed that perceptual prominence is significantly affected by different accent types ($\chi^2(7)=1815$, $p<0.0001$). Figure 3a shows that the accent types are ranked according to the hypothesis. The only unexpected result was the relatively low prominence rating for !H* accents. This may be explained by the lack of pitch excursion of this accent type in relation to the early peak accents (H+L* and H+!H*) which were judged as more prominent. Obviously, the factor *direction of pitch movement* (rise for !H* vs. fall for early peaks) was outranked by the steeper pitch excursion of the accent types displaying a falling onglide.

Figure 3: Mean ratings of perceptual prominence of different accent types: (a) voices and target words pooled, (b) target words pooled, (c) male and female voice pooled.



Furthermore, the analysis showed a significant interaction between accent type and speaker's voice ($\chi^2(7)=48.58$, $p<0.0001$; Figure 3b) as well as between accent type and target word ($\chi^2(14)=75.2$, $p<0.0001$; Figure 3c). Both effects are rather small and were generally unexpected. For some accent types, especially the low and falling ones, the male voice gave rise to higher prominence scores than the female voice. This could be due to speaker-specific (or even gender-specific) features related to pitch. A lower voice (displaying smaller distances between the upper harmonics) may trigger an impression of increased sonority, which is closely related to the perception of prominence.

The effect of target word can in part be explained by durational differences but also by sonority expansion and hyperarticulation: The open vowel /a/ in the target word *Lana* was longer and more sonorous than the vowels in *Lona* and *Lina* (cf. Table 2). Accordingly, *Lana* was judged as most prominent. However, *Lina* received higher prominence scores than *Lona*, despite its shorter duration. A possible explanation lies in the hyperarticulation of /i/. That is, the accented vowel /i/ may tend towards stronger hyperarticulation than the vowel /o/ (as found by [5] for German). Since hyperarticulation of the front high vowel has been found to be positively correlated with perceived prominence (see [20] for American English), this effect may have outweighed the longer duration of /o/ in *Lona*.

4. CONCLUSIONS

The experiment confirmed our hypothesis that the nuclear pitch accent types (plus deaccentuation) attested for German differ with respect to their perceived prominence. We attribute the varying degrees of prominence to three tonal dimensions which can be ranked according to their perceptual relevance: Most important for German listeners is the direction of pitch movement (rises are more prominent than falls) but the degree of pitch excursion (steep rises and falls are more prominent than shallow rises and falls) and the height of the starred tone (high accents are more prominent than downstepped and low accents) are relevant as well. Each accent type is a combination of different levels of these dimensions (plus duration), which do not always have to be ranked in the same way. For example, the rising accent type !H* (ranked high in terms of pitch movement direction) was perceived as less prominent than the early peak accents which are marked by a steep fall to the accented syllable.

5. ACKNOWLEDGEMENTS

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